

# Request for Proposals No. 2022-37

## Addendum 01 – Q&A

This document is posted to capture the questions received, and agency answers provided, during the question and answer period of RFP No. 2022-37, issued October 21, 2022.

All amendments, addenda, and notifications related to this procurement will be posted on the [OSPI website](#) (if this was an open procurement) and on the Washington Electronic Business Solution ([WEBS](#)) website. Additional questions concerning this procurement must be submitted to [contracts@K12.wa.us](mailto:contracts@K12.wa.us). Communication directed to other parties will be considered unofficial and non-binding on OSPI, and may result in disqualification of the Consultant.

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1. **Question:** How many attendees are expected at the Summer Institute?  
**Answer:** We are uncertain of the exact number at this time. However, up to 200 will have funding to attend in Summer 2023.  
We anticipate the ongoing expectation (after 2023) will be closer to 100.
  
2. **Question:** How many groups will be part of the Communities of Practice? What will be the total anticipated participation/attendance for this component?  
**Answer:** Communities of Practice will be virtual groups of ten (10) or less. Design for multiple groups using the same plan or framework. For the current pilot, there are three (3) CoPs (twenty-eight (28) teachers).  
The ongoing expectation (after 2023), all who attend the Summer Institute will be expected to attend the CoPs.
  
3. **Question:** What is the anticipated attendance for the Curriculum Workshops?  
**Answer:** All first-time teachers of the course will attend the Curriculum Workshops, so twenty-eight (28) this school year. Design for multiple groups of that size.  
The ongoing expectation (after 2023) is likely to limit to multiple groups of thirty (30) in the future.
  
4. **Question:** The Scope of Work section provides two components:
  - a. Materials Development  
**Answer:** Materials development refers to the facilitation materials for the modules. These materials would be delivered for use by facilitators.



b. Materials Development and Facilitation

**Answer:** This would include both the facilitation material development and leading the meetings.

5. **Question:** We are assuming that vendors cannot only apply for the Facilitation component, correct?

**Answer:** Correct, we are not interested in bidders applying only for the facilitation component. However, we would consider bidders who apply only for the material development component.

6. **Question:** Do you have a link to the course content for Modern Algebra II? We're writing our proposal for this bid and don't see anything in the RFP about the content we're being asked to write professional development materials for.

**Answer:** Materials will be provided to the Apparently Successful Bidder. Attached are a sample lesson and overview of the course.

Module	Professional Learning/Support
<b>SEMESTER 1</b>	
1. Building a Learning Culture Using Sequences	Summer Institute
2. Functions, Inverses and Transformations	Summer Institute
3. Polynomials and Rational Functions	Summer Institute (introduction only) & Community of Practice
4. Rational Exponents	Community of Practice
5. Exponential Functions	Community of Practice
<b>SEMESTER 2</b>	
Modeling with Data A. Discovering Data	Curriculum Workshop & Community of Practice
Modeling with Data B. Machine Learning	Curriculum Workshop & Community of Practice
Modeling with Quantities A. Periodicity	Curriculum Workshop & Community of Practice
Modeling with Quantities B. Money Matters	Curriculum Workshop & Community of Practice
Modeling with Algebra A. Art in the Matrix	Curriculum Workshop & Community of Practice
Modeling with Algebra B. Scientific Exploration	Curriculum Workshop & Community of Practice

Each Curriculum Workshop is ½ day, paired for a full day experience. Teachers select 4 modules to explore over 2 days.

## Modeling with Data

### Discovering Data

- Bivariate Data and Regression
- Probability to Analyze Fit
- Making Predictions
- Correlation vs Causation and Evaluating Claims



### Machine Learning

- Predictive Modeling
- Logic of Programming
- Conditional Probability
- Linear Algebra



## Modeling with Quantities

### Periodicity

- Trigonometry
- Periodic nature of Unit Circle
- Radians as arc lengths
- Applications



### Money Matters

- Applying Exponentials
- Sequences & Series
- Models for Decision Making



## Modeling with Algebra

### Art in the Matrix

- Linear Programming
- Matrices
- 3-Dimensional
- Non-linear systems



### Scientific Exploration with Algebra

- Purest form of modeling
- Uses math that is needed
- Includes polynomials, logarithms, etc



## Original Resource: based on IM Lessons 8, 9

### Lesson 7 Mystery Lesson

#### Description:

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In the previous lesson, students began to understand about the relationship between the factors of a polynomial function and the zeros of a polynomial. They began to identify and write a possible equation for a polynomial with specific  $x$ -intercepts, turning around the work they have done previously. Students also revisited vertical scaling to find an appropriate scaling factor that would match the graphs.

This lesson continues the work of previous lessons and builds on the understanding of the relationship between an equation of a polynomial function and the end behavior of the function.

Students will use language such as “larger and larger in the positive direction” and “larger and larger in the negative direction” when describing the end behavior of a function. Standard terminology and symbols are not introduced here, instead student-friendly language is used while also making the point that when we talk about the end behavior of a polynomial function  $f$  we are considering how the value of the outputs  $f(x)$  are changing in relation to inputs  $x$  of increasing magnitude.

Students examine the differences in end behavior between polynomials of even and odd degree and determine the effect of the sign of the leading coefficient on end behavior.

#### Common Core State Standards Addressed:

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- SSE.A
- IF.C

#### Mathematical Practice Standard(s) Emphasized:

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- MP7
- MP6
- MP3

#### Social Emotional Learning Standard(s) Emphasized:

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#### Resources/Instructional Materials Needed:

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Graphing technology

## Student Preparation {this references a hybrid learning environment}

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### Engage

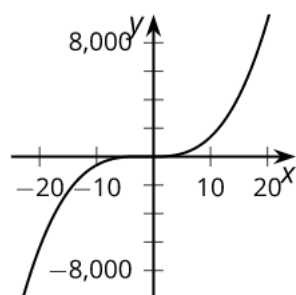
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5 mins

#### Student Facing:

The end behavior of a polynomial is what happens to the output as the input gets larger and larger in either the positive or negative directions.

How would you describe the end behaviors of this polynomial?



#### Teacher Facing:

This activity will introduce the terms end behavior, although this concept has been discussed in prior lessons absent the terminology. When students articulate their description of the end behavior, they have an opportunity to attend to precision in the language they use to describe what they see (MP6). This activity is meant to introduce the idea of end behavior. Throughout this lesson, students will continue to refine their language use.

#### Launch

Display the graph and question for all to see. Give students 1 minute of think time, and then 1 minute to discuss their description with their partner, followed by a whole-class discussion.

#### Student Response

As  $x$  gets larger and larger in the positive direction,  $y$  also gets larger and larger in the positive direction.  
As  $x$  gets larger and larger in the negative direction,  $y$  also gets larger and larger in the negative direction.

#### Activity Synthesis

## Module 3 Polynomials and Rational Functions

Ask students to share their descriptions of end behaviors. Push students for accuracy in their descriptions by asking probing questions or giving other students an opportunity to agree or disagree. At the end of the discussion, tell students that today, they are going to investigate the **end behavior** of polynomial functions. The end behavior of a polynomial is what happens to the output as the input gets larger and larger in either the positive or negative directions. For end behavior, we are using “larger” to refer to magnitude, that is, distance from 0. End behavior does not describe the zeros of a function or the intercepts of the graph, but rather, the trend of the input-output pairs of the function as we move farther from  $x = 0$ , pairs that are often outside of the graphing windows we use.

### Explore

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Activity 7.1 (15 minutes)

#### Student Facing:

1. Use the completed table of values to describe what you notice about your assigned polynomial.
2. Draw a sketch of what you think the end behavior of your polynomial looks like.

$x$	$y = x^2 + 1$	$y = x^3 + 1$	$y = x^4 + 1$	$y = x^5 + 1$
<b>-1000</b>	1,000,001	-999,999,999	1,000,000,000,001	-9,999,999,999,999,999
<b>-100</b>	10,001	-999,999	100,000,001	-9,999,999,999
<b>-10</b>	101	- 999	10,001	-99,999
<b>-1</b>	2	0	2	0
<b>1</b>	2	2	2	2
<b>10</b>	101	1,000	10,001	100,001
<b>100</b>	10,001	1,000,001	100,000,001	10,000,000,001
<b>1000</b>	1,000,001	1,000,000,001	1,000,000,000,001	1,000,000,000,000,001

#### Teacher Facing:

The goal of this activity is for students to understand why the leading term of a polynomial determines end behavior.

#### Launch

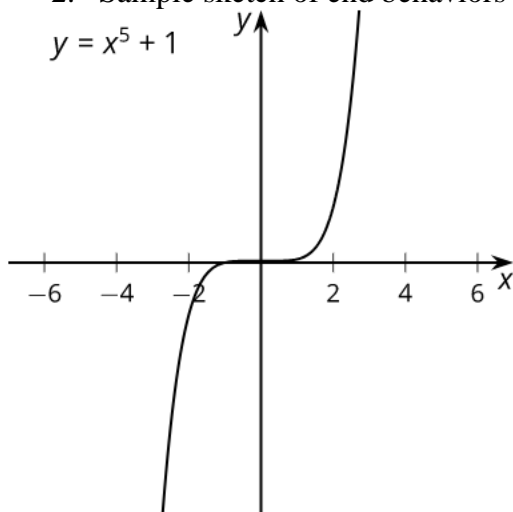
Arrange students in groups of 4, assigning each person one polynomial from the chart. Give individual work time for the questions followed by small group sharing.

#### Student Response

Sample response for  $y = x^2 + 1$

## Module 3 Polynomials and Rational Functions

1. As  $x$  gets larger and larger in the negative direction,  $f(x)$  gets larger and larger in the positive direction. As  $x$  gets larger and larger in the positive direction,  $f(x)$  gets larger and larger in the positive direction.
2. Sample sketch of end behaviors



### Activity Synthesis

The purpose of this discussion is for students to understand why the end behavior of polynomials with a leading term of odd degree differs from polynomials with a leading term of even degree. Discuss:

- “Describe the similarities and differences between the polynomials listed in the table.” (The equations with an even exponent have very large positive values of  $y$  for large negative values of  $x$ . The equations with an odd exponent have very large negative values of  $y$  for large negative values of  $x$ .)
- “How would the end behavior of the polynomials change if there was another term in the equations, like  $100x$ ?” (For values of  $x$  near 0, there would be a change, but the end behavior would not change, since 100 is a small number compared to 1 million or -999,999,999.)

Tell students that one way to describe the end behavior is by stating what happens to the output values as the input values move away from 0. For example, for  $y = x^3 + 1$ , we can say that as  $x$  gets larger and larger in the negative direction,  $y$  gets larger and larger in the negative direction. As  $x$  gets larger and larger in the positive direction,  $y$  gets larger and larger in the positive direction. For  $y = x^4 + 1$ , as  $x$  gets larger and larger in the negative direction,  $y$  gets larger and larger in the positive direction. As  $x$  gets larger and larger in the positive direction,  $y$  gets larger and larger in the positive direction. The “larger and larger” language is used to be clear that no matter how large you go (since you can never zoom out far enough to see the entire polynomial), you know what the output values are doing.

To summarize, if we consider the polynomial  $y = 2x^5 - 5x^4 - 30x^3 + 5x^2 + 88x + 60$ . What is the degree? (Ans: 5). Since 5 is odd what do we know about the end behaviors? (Ans: As  $x$  gets larger and larger in the negative direction,  $y$  gets larger and larger in the negative direction. As  $x$  gets larger and larger in the positive direction,  $y$  gets larger and larger in the positive direction).

## Module 3 Polynomials and Rational Functions

### Activity 7.2 (15 minutes)

#### Student Facing:

1. Write an equation for a polynomial with the following properties:
  - It has an even degree
  - It has at least 2 terms
  - As the inputs get larger and larger in either the negative or positive directions, the outputs get larger and larger in the negative direction.
2. Write an equation for a polynomial with the following properties
  - It has an odd degree
  - It has at least 2 terms
  - As the inputs get larger and larger in the negative direction, the outputs get larger and larger in the positive direction.
  - As the inputs get larger and larger in the positive direction, the outputs get larger and larger in the negative direction

#### Teacher Facing:

The purpose of this activity is to address how the leading coefficient being positive or negative changes the end behavior of a polynomial. Working in small groups is meant to give students more equations to compare as they learn which features of an equation match with different output behaviors.

#### Launch

Arrange students in groups of 4. Give individual work time for the first question followed by small group sharing of the different equations written. Invite groups to share 1–2 equations and record these for all to see. Tell groups to discuss what similarities and differences they see between the equations before starting work on the last question.

#### Student Response

1. Sample response  $y = -(x^2 + 3)$
2. Sample response  $y = -x^3 + 2x - 1$

#### Activity Synthesis

The goal of this discussion is to make sure students understand that if the leading term has a negative coefficient, then the end behavior of the graph will be “flipped” when compared to an equation of the same degree with a positive leading coefficient. This also means that even polynomials still have matching end behavior and odd polynomials do not.

Select 2–3 groups to share some of the odd degree equations they wrote and record these for all to see alongside the list of the even degree equations. After some quiet think time, ask groups to write a brief summary of which parts of an equation can be used to identify end behavior (the leading term) and

## Module 3 Polynomials and Rational Functions

which parts do not affect the end behavior (all other terms). Invite groups to share their summaries and help the class reach agreement.

### Lesson Synthesis

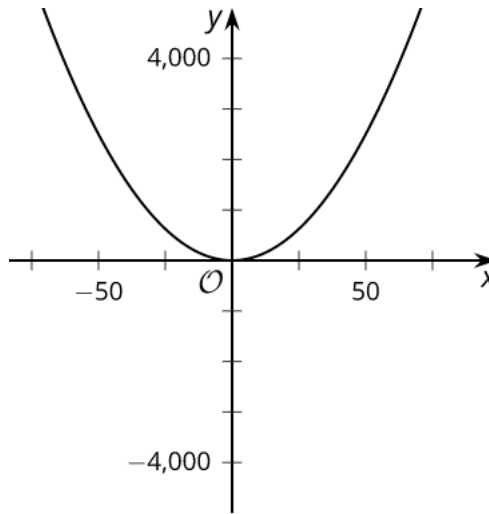
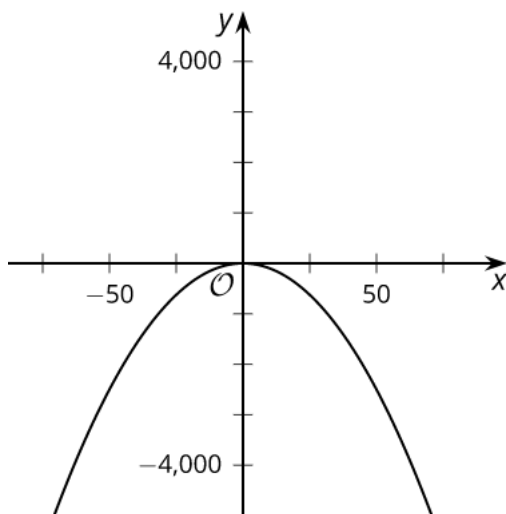
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10 mins

#### Student Facing:

What happens when we multiply a number by a negative number? If the original number was positive, the product is negative. But if the original number was negative, the product is positive. The sign of the new number is the opposite of the original number.

Now let's consider the polynomial functions  $f(x) = x^2$  and  $g(x) = -x^2$ . For any non-zero real number  $x$ , the output of  $f$  is positive while the output of  $g$  is negative. The signs of all the output values for  $g$  are the opposite of those of  $f$ . The difference between these two functions is also easy to see when we look at their graphs.

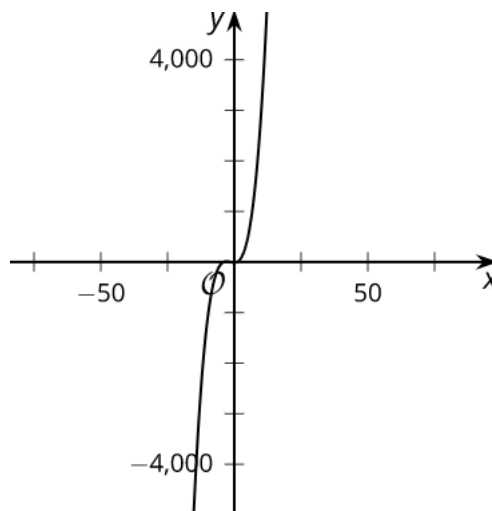
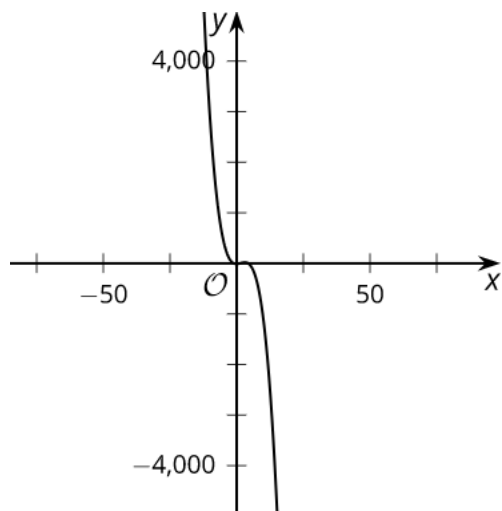


This

is the effect of a negative leading coefficient: the end behavior of the polynomial is the opposite of what it would be if the leading coefficient were positive. For polynomials of odd degree, we can see that a negative leading coefficient has the same effect on the end behavior.

Here are the graphs of  $y = -(x - 1)(2x + 3)(x + 4)$ , which has a leading term of  $-2x^3$ , and  $y = (x - 1)(2x + 3)(x + 4)$ , which has a leading term of  $2x^3$ . They have the same zeros, but opposite end behavior, because they have opposite signs on their leading coefficients.

## Module 3 Polynomials and Rational Functions



### Teacher Facing:

You will be using your whiteboard to share your response. I will show you a polynomial equation and ask that you identify what the end behavior will be and then draw a quick sketch.

1. Pass out individual whiteboards (or similar). Ask students to stand up with their whiteboard while you explain the rules of the game.
2. A series of polynomial equations will be displayed one at a time.
3. After an equation is displayed, there will be a brief quiet think time to identify the end behavior and draw a sketch. Give a hand signal when you are ready.
4. When you hear “Show!”, flip your whiteboard forward toward the front to display the end behavior of the function.

Here are some polynomial equations to use. Have a graph of each ready to show for students to check against their answer. Occasionally, ask a student to share their board with the class and ask another student to explain the thinking / strategy.

- $y = x$
- $y = x^4$
- $y = 3x^2 + 2x - 2000000$
- $y = 3x - 7 + x^2$
- $y = x^5 + 6x^4 - x^5 - 2x + 8$
- $y = (x - 3)(x + 4)(2x + 1)$
- $y = x^{10}$
- $y = x^{25}$
- $y = x^{50}$
- $y = x^{101}$

## Closing Activity

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5 Minutes

### Student Facing:

Describe the end behavior of  $y = -x^4 + x^2 - x + 1$ .

### Student Response:

As  $x$  gets larger and larger in the negative or positive direction,  $f(x)$  gets larger and larger in the negative direction.

### Teacher Facing:

Students will have more opportunities to understand the mathematical ideas in this cool-down, so there is no need to slow down or add additional work to the next lessons. Instead, use the results of this cool-down to provide guidance for what to look for and emphasize over the next several lessons to support students in advancing their current understanding.

## Student Follow Up/Extension/Practice

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1. Match each polynomial with its end behavior. Some end behavior options may not have a matching polynomial and options may be used more than once.

## Module 3 Polynomials and Rational Functions

A:

$$f(x) = 5x^2 - 2x + 1$$

B:

$$f(x) = 6x^3 + 4x^2 - 15x + 32$$

C:

$$f(x) = 7x^4 - 2x^3 + 3x^2 + 8x - 10$$

D:

$$f(x) = 8x^6 + 1$$

E:  $f(x) = -2x + 3$

F:  $f(x) = x^2 - 6x + 3$

G:  $f(x) = 1 - x^2 + 2x^3$

:

H:  $f(x) = 7 - x^4$

1:

As  $x$  gets larger and larger in either the positive or negative direction,  $f(x)$  gets larger and larger in the positive direction.

2:

As  $x$  gets larger and larger in the positive direction,  $f(x)$  gets larger and larger in the positive direction. As  $x$  gets larger and larger in the negative direction,  $f(x)$  gets larger and larger in the negative direction.

3:

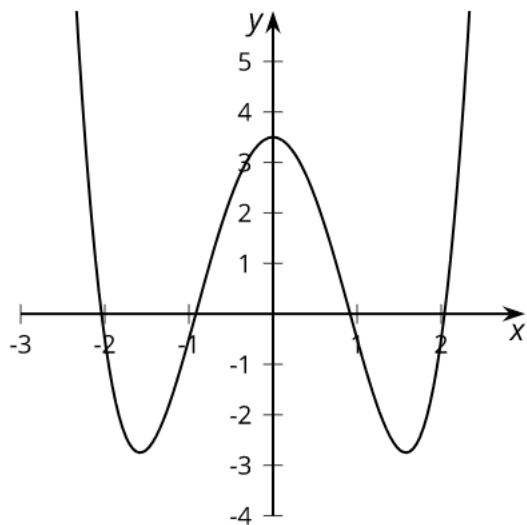
As  $x$  gets larger and larger in the positive direction,  $f(x)$  gets larger and larger in the negative direction. As  $x$  gets larger and larger in the negative direction,  $f(x)$  gets larger and larger in the positive direction.

4:

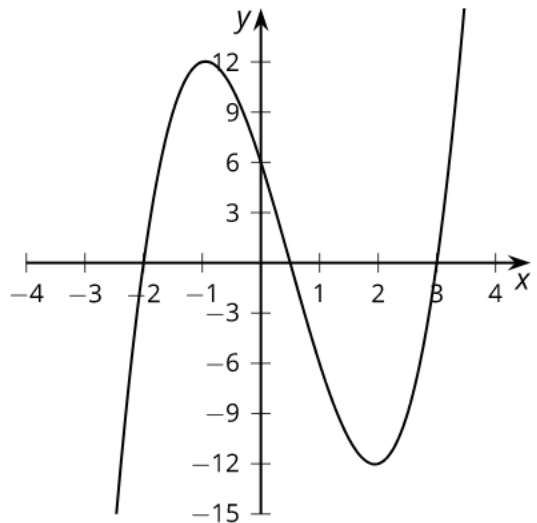
As  $x$  gets larger and larger in either the positive or negative direction,  $f(x)$  gets larger and larger in the negative direction.

2. The graph of the polynomial function  $f$  is shown. Write a statement about the zeros, x-intercepts, and degree.

### Module 3 Polynomials and Rational Functions



3. State the degree and end behavior of  $f(x) = -x^3 + 5x^2 + 6x + 1$ . Explain or show your reasoning.
4. The graph of a polynomial function  $f$  is shown. Select all true statement about the polynomial.



- A: The degree of the polynomial is even.  
B: The degree of the polynomial is odd.  
C: The leading coefficient is positive.  
D: The leading coefficient is negative.  
E: The constant term of the polynomial is positive.  
F: The constant term of the polynomial is negative

## Module 3 Polynomials and Rational Functions

### Solutions

1.

A:1

B:1

C:1

D:2

E:3

F:1

G:2

H:4

2. zeros = 2,  $-1/2$ ,  $-3$ , x-intercepts =  $-2$ ,  $1/2$ ,  $3$ , degree is even.

3. Sample response:  $f(x)$  has a degree of 3 since the leading term is  $-x^3$ . As  $x$  gets larger and larger in the positive direction,  $f(x)$  gets larger and larger in the negative direction. As  $x$  gets larger and larger in the negative direction,  $f(x)$  gets larger and larger in the positive direction.

4. B,C,E